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SCREENING OF CIP ADVANCED POTATO GENOTYPES AGAINST DROUGHT IN NORTHERN REGION OF BANGLADESH

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ABSTRACT

Eleven advanced potato (*Solanum tuberosum*) clones developed by CIP, Lima and three local checks screened at BRAC, Dinajpur during 2009-10 for their performance against drought. Three irrigation regimes adopted were; normal irrigation, two irrigations (1st at earthing up and 2nd after following 30 days) and one irrigation. Significant differences have been reported between the clones and irrigation treatments in most traits. In general, as water stress increased, vegetative growth and tuber yield decreased. Plant height decreased significantly with reduced irrigation especially under one irrigation treatment from 76.9cm (normal irrigation) to 64.8cm at 75 Days after Planting (DAP). Similarly, at 45 and 60 DAP plant height decreased from normal to one irrigation regime. Tuber number per plant and plot also reduced from normal irrigation to one irrigation treatment. Normal irrigation system produced highest number of tuber (11.4) compared to two irrigations (11.1) and a single irrigation (9.3) treatment. In experimental plot minimum number of tuber found from one irrigation (119) compared to two (186) and normal irrigation treatment. Average tuber weight also found less in one irrigation (54.64 g) compared to two (61.42) and normal irrigation regime (65.00). Tuber yield per plant was found maximum in normal (530.0 g plant^{-1}) and minimum in single irrigation (435.0 g). Marketable and total tuber yield in water stress therefore, reduced due to tuber number, tuber weight plant^{-1} found minimum in water deficit conditions. Considering yield and other yield attributes clones CIP-101, CIP-111 and CIP-126 produced satisfactory yield at drought condition. These could be promising and moderately tolerant to drought in northern part of Bangladesh.

***Key words**: Drought, Irrigation, Potato, Tuber, Yield*

INTRODUCTION

Drought is a period without significant water in soil that affects the plant growth, development and reproduction. It is now a major limiting factor for potato production in the world influencing yield as well as tuber quality. Now global environment is being changed due to climate change. Drought is one of the most unwanted output results of climate change in the world. Bangladesh is now facing some problem created by climate change. Drought is major one among them in the northern part of Bangladesh. Drought may occur due to erratic rainfall, inadequate irrigation techniques, lack of water supply and atmospheric conditions cause continuous loss of water by transpiration or evaporation. Water deficit is a global issue that needs to be taken into consideration to ensure survival of agricultural crops and sustainable food production. Drought-stress tolerance is common in almost all plant species but its extent varies from species to species. (Jaleel *et al.,* 2009). Selection of appropriate genotypes is going to be one of the major crop adaptation strategies under changing scenario of global climate change for crops as abiotic and biotic stresses would put more pressure on crops particularly potatoes affecting its productivity negatively in future (Haverkort and Verhagen, 2008). R. Schlafleitner (2008) stated that many of the ancient potato landraces are adapted to different environmental conditions such as different soils, temperature, altitude and drought. It's good news and therefore, we can minimize the drought effect by searching the resistant landraces. Bangladesh is a over populated country and its population is being increased continuously. To feed the present and upcoming generation is a big challenge. Scientists are trying to find out new variety suited to cultivate in adverse conditions and new region where problems are. As that aspect, some advanced CIP potato clones were screened under field conditions for water stress of varied irrigation regime to identify suitable drought tolerant genotype for sustainable tuber production.

MATERIALS AND METHODS

A field experiment was conducted during the winter (Rabi) seasons of 2009-2010 at BRAC, Dinajpur in a Strip-plot design with three replications. There were three treatments; T_1: Normal Irrigation (3) as practiced by farmer, T_2: One irrigation after 1st earthing up at 30 Days after Planting (DAP) and T_3: Two irrigations after earthing up at 30 & 60 DAP. Eleven selected CIP clones (CIP-101, CIP-102, CIP-111, CIP-117, CIP-124, CIP-126, CIP-129, CIP-130, CIP-134, CIP-137 and CIP-139) were planted with three checks (Diamant, Lalshil & Lalpakri) for screening in drought condition. The protocol of drought tolerance trial has already been established at CPRI, India and the same protocol was followed in Bangladesh trials. The experiment was planted on 22 December, 2009. Well-sprouted seed tubers were planted at a spacing of 60cm × 20cm in plots of 1.8m × 2.0m. Fertilizers were applied @ 325-220-250-120 kg ha^{-1} of Urea, TSP, MOP and Gypsum, respectively. Full amount of TSP, MP and Gypsum and 50% of urea were applied as basal and the remaining amount of urea was top dressed at 35 DAP. Weeding, pesticide spraying and other intercultural operations were done as and when necessary. The crop was harvested at 90 DAP. All the yield and yield contributing characters data were recorded and were statistically analyzed.

RESULTS AND DISCUSSIONS

Plant height

Plant height showed a significant variation to irrigation response among the clone and varieties. It decreased significantly with an increase in the water deficit. The mean plant height decreased from 76.9cm (normal irrigation) to 73.7cm (two irrigations) and 4.8 cm (1 rrigation) at 75 DAP. It was the highest in CIP- 134 followed by CIP-139 at 75 DAP. Data in Table 1 clearly shows that the decreasing tendency in each genotype from normal to mild and severe water deficit conditions at 40, 60 and 75 DAP. It was happened due to decline in cell enlargement (hypertrophy) by the effect of water stress. So, cell enlargement is associated with plant height. This findings confirmed by kumar *et al.* (2007), Shao *et al.* (2008) and Jaleel *et al*. (2009).

Number of tubers plant^{-1}

Total tuber number per plant is one of the most important yield contributing attributes in potato crop and it is to be examined. Cultivar Lalpakri recorded maximum and significantly higher number of tuber (26.7) plant^{-1} as compared to other genotypes. In contrast, minimum mean total number of tuber plant^{-1} (5.50) was found in genotypes CIP-129. In all the genotypes number of tuber plant^{-1} was observed lower in one irrigation regime than the other two treatments. This result clearly indicated that deficit water availability in active growth phase declined total number of tuber plant^{-1}. Least tuber number (9.3) was found under single irrigation system. This was more or less visible among various genotypes including checks Diamant, Lalpakri and Lalshil. Similar pattern of decrease in mini tuber number was also observed by Hassanpanah (2010) among varieties with varied moisture conditions under both *in vitro* and *in vivo* crop growth conditions. Schafleitner *et al*. (2007) stated that reduction in tuber number may be mainly attributed to variations in enzymatic activities, which are ultimately governed by expression or suppression of genes under soil moisture deficit.

Tuber weight plant^{-1}

From table 2, it can be stated that such a significant difference among the different treatment levels of irrigation. Maximum mean tuber weight per plant found from normal irrigation followed by two and one irrigation. Clone CIP-101 and CIP-134 produced highest weight of tuber per plant. Clone CIP-101 also produced maximum and significantly higher weight of tuber per plant (666.67). Clone CIP-124 gave highest tuber weight per plant both in one and two irrigation system. In this case all the genotypes showed a reduced yield tendency in deficit water condition compared to other irrigation system. Deblonde and Ledent (2001) reported that Different growth strategies by plants to adapt to different levels of drought without a significant to be used decrease in yield.

Average tuber weight

Average tuber weight also affected significantly by the irrigation system. Mean maximum tuber weight found in clone CIP-126 (113.33g) and minimum (10g) in Lalshil and Lalpakri. Here also found similar pattern of average weight of tuber. This finding described the decreasing average tuber weight with increasing water deficit. Average tuber weight directs the yield of potato crop. Reduced crop growth under water deficit condition might lead led to decrease photosynthetic area (Sharma *et al.* 2011) an d as a result plant produced lower weight of tuber compared to normal and two irrigation system.

Table 1. Effect of irrigation and clones/varieties on plant height of potato

CIP clones/variety	Plant height (cm) at											
	45 DAP			Mean	60 DAP			Mean	75 DAP			Mean
	T1	T2	T3		T1	T2	T3		T1	T2	T3	
CIP-101(301024.14)	56.6	38.6	43.9	46.38	77.4	51.1	62.7	63.73	85.0	70.3	70.3	75.18
CIP-102 (301029.18)	25.8	26.3	31.7	27.93	55.1	45.5	61.9	54.18	62.7	69.5	69.5	67.22
CIP-111 (380583.8)	38.9	36.2	41.3	38.78	75.2	59.7	71.4	68.76	82.8	79.0	79.0	80.27
CIP-117 (386292.3)	42.6	29.4	39.7	37.22	64.2	43.1	61.6	56.29	71.8	69.2	69.2	70.07
CIP-124 (392781.1)	41.1	34.4	44.9	40.15	61.5	47.4	64.5	57.80	69.1	72.1	72.1	71.11
CIP-126 (392797.22)	45.5	34.3	47.0	42.25	75.6	60.8	68.7	68.38	83.2	76.3	76.3	78.62
CIP-129 (393536.13)	43.1	32.5	39.3	38.29	71.4	55.1	64.0	63.51	79.0	71.6	71.6	74.07
CIP-130 (393617.1)	48.0	34.2	43.9	42.04	75.5	49.4	67.3	64.07	83.1	74.9	74.9	77.64
CIP-134 (395183.7)	54.7	41.7	44.9	47.11	72.7	60.3	70.7	67.93	80.3	78.3	78.3	79.00
CIP-137 (395193.6)	51.0	60.9	42.9	51.58	72.4	56.7	66.5	65.20	80.0	74.1	74.1	76.09
CIP-139 (396311.1)	36.0	36.9	43.9	38.91	59.9	62.3	71.3	64.49	67.5	78.9	78.9	75.11
Diamant	49.1	33.4	42.4	41.62	65.7	50.1	64.7	60.16	73.3	72.3	72.3	72.62
Lalshil	42.7	36.7	40.3	39.93	75.4	61.6	69.8	68.93	83.0	77.4	77.4	79.27
Lalpakri	40.3	31.5	37.0	36.27	67.5	47.9	59.7	58.36	75.1	67.3	67.3	69.89
Mean	44.0	36.2	41.6		69.3	53.6	66.1		76.9	73.7	73.7	
Statistics	SEm ±		$CD_{0.05}$		SEm ±		$CD_{0.05}$		SEm ±		$CD_{0.05}$	
Irrigation (I)	6.47		4.00		2.23		3.30		5.29		0.32	
Clone/variety (V)	8.28		8.66		6.19		7.19		40.66		0.69	
Interaction I × V	6.19		14.99		5.14		12.46		28.03		0.97	

T_1: Normal Irrigation; T_2: One Irrigation; T_3: Two Irrigation (1st at earthing and 2nd after 30 days)

Table 2. Effect of irrigation and clones/varieties on number & weight of tubers

CIP clones/variety	Tubers Number /Plant			Mean	Average Tuber Weight (g)			Mean	Tuber wt./Plant (g)			Mean
	T_1	T_2	T_3		T_1	T_2	T_3		T_1	T_2	T_3	
CIP-101(301024.14)	10.0	9.7	11.8	10.51	70	60	60	63.33	710	630	660	666.67
CIP-102 (301029.18)	6.8	5.8	6.0	6.21	70	80	60	70.00	460	470	370	433.33
CIP-111 (380583.8)	7.9	8.6	9.8	8.76	70	60	50	60.00	560	470	510	513.33
CIP-117 (386292.3)	9.6	8.4	9.5	9.18	60	70	60	63.33	610	600	540	583.33
CIP-124 (392781.1)	6.8	6.1	8.4	7.08	90	90	70	83.33	580	500	530	536.67
CIP-126 (392797.22)	6.7	5.4	6.0	6.01	100	120	120	113.33	660	640	690	663.33
CIP-129 (393536.13)	4.9	4.7	6.9	5.50	80	80	60	73.33	400	360	430	396.67
CIP-130 (393617.1)	9.4	8.8	13.4	10.52	60	60	40	53.33	560	490	550	533.33
CIP-134 (395183.7)	10.6	8.1	9.0	9.26	70	60	70	66.67	710	480	670	620.00
CIP-137 (395193.6)	8.8	5.4	9.0	7.76	60	50	50	53.33	510	290	470	423.33
CIP-139 (396311.1)	7.6	6.7	7.2	7.18	70	60	80	70.00	510	420	470	466.67
Diamant	12.0	7.3	9.6	9.62	50	50	50	50.00	590	360	520	490.00
Lalshil	25.5	24.4	21.3	23.71	10	10	10	10.00	200	130	180	170.00
Lalpakri	32.8	20.2	26.7	26.58	10	10	10	10.00	360	250	360	323.33
Mean	11.4	9.3	11.1		62.1	61.4	56.4		530.0	435.0	496.4	
Statistics	SEm ±		$CD_{0.05}$		SEm ±		$CD_{0.05}$		S Em ±		$CD_{0.05}$	
Irrigation (I)	1.38		1.02		0.00		0.00		0.05		0.03	
Clone/variety (V)	2.27		2.19		0.00		0.00		0.06		0.07	
Interaction I × V	1.57		3.80		0.00		0.00		0.05		0.13	

Table 3. Effect of irrigation and clones/varieties on number of tubers plot^{-1}

CIP clones/variety	No. of Marketable Tubers/Plot			Mean	No. of Total Tubers/Plot			Mean
	T_1	T_2	T_3		T_1	T_2	T_3	
CIP-101(301024.14)	83.7	82.0	92.7	86.11	100.3	93	118.3	103.87
CIP-102 (301029.18)	49.7	47.7	39.3	45.56	65.33	58.33	60.33	61.33
CIP-111 (380583.8)	57.0	59.7	62.0	59.56	78.67	83.33	97.67	86.56
CIP-117 (386292.3)	79.0	63.7	66.3	69.67	96	81.67	95	90.89
CIP-124 (392781.1)	57.0	51.0	65.0	57.67	68	60.67	83.67	70.78
CIP-126 (392797.22)	56.0	49.7	49.3	51.67	66.67	54	59.67	60.11
CIP-129 (393536.13)	43.0	38.7	52.7	44.78	48.67	47	69.33	55.00
CIP-130 (393617.1)	66.0	63.3	92.7	74.00	87.67	86	128.7	100.79
CIP-134 (395183.7)	89.3	63.0	76.0	76.11	106.3	81	90.33	92.54
CIP-137 (395193.6)	73.3	36.7	59.0	56.33	85	52	87	74.67
CIP-139 (396311.1)	58.0	45.0	53.3	52.11	76	67	72.33	71.78
Diamant	95.3	49.7	70.3	71.78	115.3	72.67	96.33	94.77
Lalshil	159.7	148.3	118.3	142.10	254.7	243.7	187.3	228.57
Lalpakri	240.0	119.3	198.0	185.77	327.7	202.3	267.3	265.77
Mean	86.2	65.5	78.2		112.594	91.6193	108.09	
Statistics	SEm ±		$CD_{0.05}$		SEm ±		$CD_{0.05}$	
Irrigation (I)	10.81		7.70		13.29		8.95	
Clone/variety (V)	21.25		16.64		22.98		19.33	
Interaction I × V	11.89		28.82		13.81		33.47	

Table 4. Effect of irrigation and clones/varieties on tubers yield (t ha^{-1})

CIP clones/variety	Marketable Yield (t/ha)			Mean	Total Yield (t/ha)			Mean
	T_1	T_2	T_3		T_1	T_2	T_3	
CIP-101(301024.14)	46.44	40.87	42.89	43.40	47.62	42.00	43.73	44.45
CIP-102 (301029.18)	30.12	30.44	21.33	27.30	30.86	31.45	24.91	29.07
CIP-111 (380583.8)	35.33	27.65	26.73	29.91	37.44	31.16	34.24	34.28
CIP-117 (386292.3)	39.11	37.92	32.67	36.57	40.38	40.00	35.89	38.76
CIP-124 (392781.1)	37.89	32.22	33.11	34.41	38.67	33.18	35.33	35.73
CIP-126 (392797.22)	43.11	42.22	43.44	42.92	43.82	42.60	45.67	44.03
CIP-129 (393536.13)	26.11	22.22	25.11	24.48	26.49	24.25	28.78	26.50
CIP-130 (393617.1)	36.30	30.94	32.12	33.12	36.93	32.52	36.72	35.39
CIP-134 (395183.7)	45.78	31.11	39.78	38.89	46.89	31.96	44.36	41.07
CIP-137 (395193.6)	32.22	18.32	23.88	24.81	33.70	19.28	31.28	28.09
CIP-139 (396311.1)	32.22	26.67	27.89	28.93	33.78	27.82	30.89	30.83
Diamant	37.36	18.89	26.22	27.49	39.31	23.67	34.55	32.51
Lalshil	11.56	7.33	9.67	9.52	13.11	8.78	11.93	11.27
Lalpakri	22.22	14.44	20.89	19.18	24.22	16.80	23.67	21.56
Mean	33.98	27.23	28.98		35.23	28.96	33.00	
Statistics	SEm ±		$CD_{0.05}$		SEm ±		$CD_{0.05}$	
Irrigation (I)	1.02		0.73		3.13		2.21	
Clone/variety (V)	1.18		1.58		3.89		4.77	
Interaction I × V	1.13		2.73		3.40		8.95	

T_1: Normal Irrigation; T_2: One Irrigation; T_3: Two Irrigation (1st at earthing and 2nd after 30 days)

Number of marketable and total tuber

Marketable tubers (>20g) decreased linearly as the water deficit increased but the difference between one and two irrigation is less compared to one and normal irrigation. Because the plant get mild stress as irrigation was given up to 60 days. In one irrigation system the plant get sufficient water at initial vegetative and stolon formation stage but afterwards water stress became limiting factor for proper tuberization and attaining size of marketable grade. From one irrigation system cultivar Lalshil produced highest total and marketable tuber per plot followed by Lalpakri at 30 Days after Planting. Among the CIP clone CIP- 101 recorded highest number of total and marketable tuber per plot. Not only highest number of tuber producer but also other genotype gave the reducing tendency. Similar findings found by Deblonde and Ledent (2001), Hassan *et al.* (2002), Kumar *et al.*(2007) and Hassanpanh (2010).

Marketable and total yield

Total and marketable tuber productivity and their stability under any kind of stress is most pertinent factor in screening of genetic materials. Generally maximum marketable tuber yield is the farmer's ultimate goal to get highest benefit from potato cultivation. In this study the clone CIP-126 produced highest marketable and total tuber yield followed by the clone CIP- 101 under severe water deficit conditions. Similarly maximum mean results were found both in total and marketable tuber yield from the same genotype (CIP-126 and CIP-101). On the other hand, control cultivars Lalshil and Lalpakri recorded minimum mean marketable and total tuber yield. Diamant also did not give a satisfactory yield under one irrigation supplying system. Here therefore, over clones and varieties the marketable and total tuber decreased significantly with an increase in water stress. Similar pattern of tuber yield reduction due to water stress has been reported in potato by many researchers (Faberiro *et al*., 2001, Kashyap and Panda, 2002, Tourneux *et al*., 2003, Schafleitner *et al*., 2007).

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